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ABSTRACT

A description is presented of undergraduate and graduate programs established at Murray State University (Kentucky) to train teachers for teaching mathematics in elementary school. Courses emphasize methods and techniques used in teaching elementary pupils and developing understanding of the basic laws and principles of mathematics. Each program description includes discussion of the objectives of prospective teachers, the program population, procedures, self assessment worksheets, and recommendations for suppplementary reading and study. A checklist of assignments for the courses is provided. (JD)

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# PLANNING MATHEMATICS EDUCATION AS A DIRECTIVE AND RESPONSIVE DELIVERY SYSTEM: A COMPONENT OF TEACHER TRAINING/EDUCATION AT MURRAY STATE UNIVERSITY, MURRAY, KENTUCKY

This paper was submitted by Willis N. Johnson, ED.D in response to and after a one year involvement in Teacher Education at Murray State University and the public schools in Western Kentucky.

U S DEPARTMENT OF HEALTH, EDUCATION & WELFARE
NATIONAL INSTITUTE OF EDUCATION

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SECTION I

MATHEMATICS EDUCATION: UNDERGRADUATE

Objectives

Population

Procedures

Preliminary Self Assessment

Recommendations

Objectives:

The program objectives submitted to NCATE for ELE 201: The Teaching of Mathematics are designed to emphasize methods and techniques used in teaching elementary pupils and developing understanding of the basic laws and principles of mathematics. The program provides the opportunity for each student to participate as a teaching aide in a public school system.

The major goals are to:

A. build awareness of algebra and geometry as parts of the elementary mathematics program.

B. develop the understanding necessary to plan a meaningful, purposeful, and realistic mathematics program.

C. help students broaden their scope of mathematics and professional literature about it.

D. emphasize the structure of the Hindu-Arabic number system and show how it operates in the various processes.

E. guide students in clarifying the essentials of our system of numeration, including the decimal system.

F. give emphasis to the provision for discovery of facts, meanings, and procedures leading to insight and understanding.

G. help students recognize and provide for the great range of ability in an elementary class.

H. develop in students the ability to communicate ideas involving quantitative relationships through a rich and meaningful vocabulary.

I. emphasize the use of the kinds of materials needed to teach mathematics effectively, such as exploratory, visual, and symbolic materials.

J. help students realize that what is to be learned should be presented in such a way that the perception of generalizations and relationships is facilitated.

K. build a realization of the importance of using a wide variety of learning experiences and instructional materials adapted to each child's level of development.

L. emphasize learning as a growth process which leads gradually to responses of increasingly more mature levels.

M. clarify the principle of learning that the necessary practice to develop control and proficienty of skills should not be assigned until the learner understands what he is to practice.

N. develop an appreciation of the role of mathematics in our rapidly changing society.

O. develop an understanding of the dependence of civilization upon adequate mathematics.

Suggested experiences include:

A. using as resources the basic textbook, magazine articles, and professional books.

B. viewing films and filmstrips as a group and individually.

C. examining and evaluating basal textbooks along with their teacher's editions and manuals.

D. helping students express the history of the development of the mathematics program with emphasis on current research, content, and practice.

E. observing the teaching of mathematics by cooperating teachers in the college demonstration school, and following up observations.

F. developing arithmetic teaching-aid materials and activities planned toward specific skills and/or concepts for definite achievement levels.

G. participation in sub-group discussions relative to methods, techniques, materials, activities, equipment, and other pertinent areas.

H. examining standardized tests.

I. furthering in actual sessions the students' skills in mathematics in such as sets, numeration, number bases, number line, mathematical sentences, and geometry.

J. keeping a file of ideas in such forms as a handbook, a notebook, or a note card file.

K. participating as a teacher-aide in a public school system.

Text and suggested supplementary books are:

The textbook is Emma E. Holmes' Mathematics Instruction for Children, Wadsworth Publishing Co., Inc., 1968.

A. Ashlock, Robert B. and Herman, Wayne L., Jr. Current Research in Elementary School Mathematics. Macmillan, 1970.

B. Buckeye, Donald A. and Ginther, John L. Creative Mathematics. Canfield Press, 1971.

C. Copeland, Richard W. How Children Learn Mathematics. Macmillan, 1970.

D. Cumas, Enoch. Math Activities for Child Involvement. Allyn and Bacon, Inc., 1971.

E. Grastens, Helen L. and Jackson, Stanley B. Mathematics for Elementary School Teachers. Macmillan, 1967.

F. Heddens, James W. Today's Mathematics. Second edition. Science Research Associates, Inc., 1964.

G. Heimer, Ralph T. and Newman, Mariam S. The New Mathematics FOR Parents. Holt, Rinehart, Winston, Inc., 1965.

H. Hirschi, L. Edwin. Building Mathematics Concepts in Grades Kindergarten through Eight. International Textbook Company, 1970.

I. Kidd, Kenneth P. and others. The Laboratory Approach to Mathematics. Science Research Associates, Inc., 1970.

J. Kramer, Laas. Problems in the Teaching of Elementary School Mathematics. Allyn and Bacon, Inc., 1970.

K. Kramer, Laas. Teaching Elementary School Mathematics. Allyn and Bacon, Inc., 1970.

L. Lovell, Kenneth. The Growth of Understanding in Mathematics: Kindergarten through Grade Three. Holt, Rinehart, and Winston, Inc., 1971.

M. May, Lola June. Teaching Mathematics in the Elementary School. The Free Press, 1970.

N. McMeen, George H. and Goodfellow, Hames W. Fundamentals of Mathematics. American Book Company, 1969.

Journals suggested:

A. The Arithmetic Teacher

B. Grade Teacher

C. The Instructor

The foregoing objectives have been synthesized to only six objectives. A careful reading will demonstrate that the previous fifteen objectives are adhered to in the more parsimonious listing. These objectives are:

1. Demonstrate appropriately, psycho-motor and perceptual aids in conceptualizing mathematics concepts and skills.

2. Demonstrate the ability to sequence learning from "real experiences" to the more abstract form of experience.

3. Demonstrate a variety of ways of reinforcing learning for mastery.

4. Demonstrate knowledge of affective concerns in learning mathematics and how to deal with them.

5. Demonstrate knowledge of the scope and sequence of concepts and skills taught from kindergarten through the eighth grade.

6. Demonstrate the ability to help learners attain an identified objective.

An examination of Figure 1.should aid the reader in seeing the process used in meeting these objectives. The four objectives fall into two general categories: 1) Teaching though Developmental and Mastery Strategies (four objectives) and 2) Determining What to Teach by Examining Goals and Assessments (two objectives). These objectives are met both without children (by using guided assignments) and with children (in the public school environment). (For more detail please examine Appendix A of this document.)

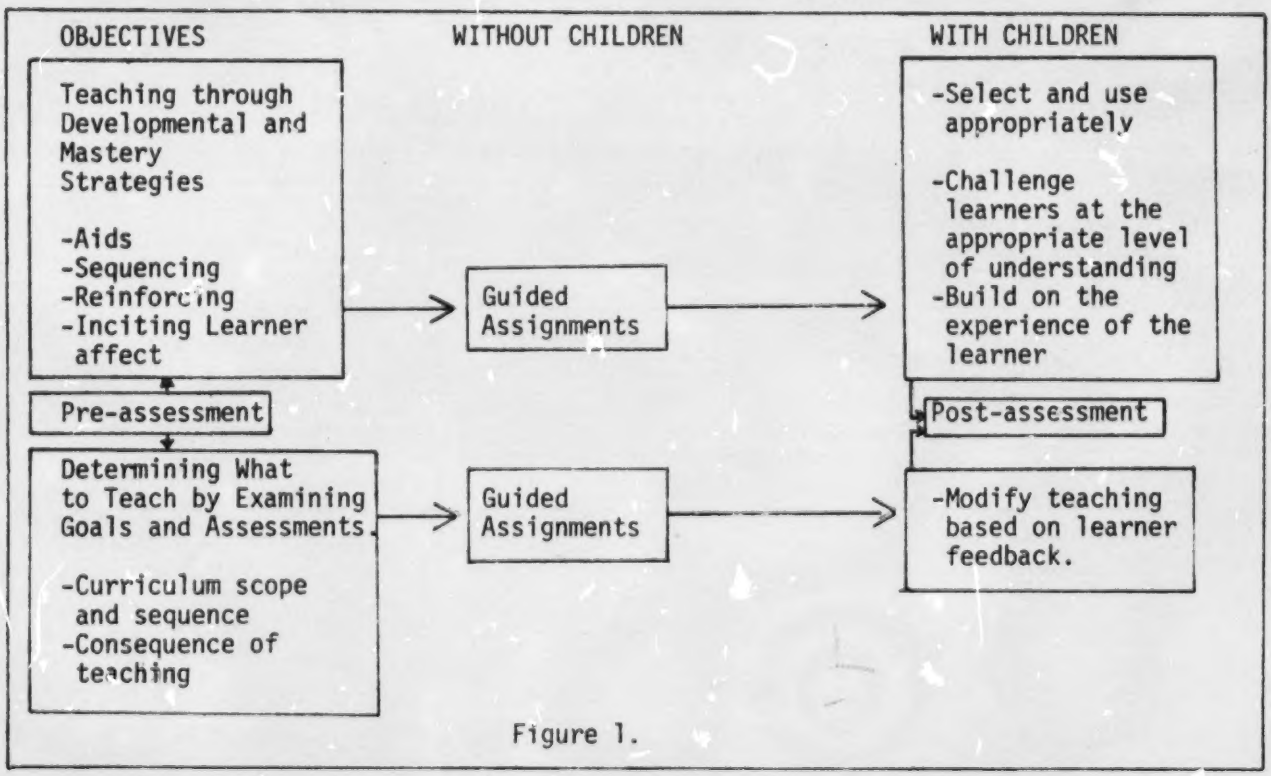


Figure 1.

## The Population of ELE 201 and SME 100, 150, 200, 250

Historically, the class structure of ELE 201 has been composed of twenty five to thirty five undergraduate students of varying backgrounds and interests. At MSU the student tends to be at the sophomore level. The majority of students are female around the age of twenty. Usually, the student has one of the two required university mathematics courses for teachers behind them. More often than not, students enter ELE 201 with a "fear of mathematics". Increasingly, the students that comprise ELE 201 are transfers from an accredited junior or community college.

The NSF funded Integrated Science and Mathematics Education Project is in its second year of operation. The students are invariably 100% MSU matriculating students. None (at this writing) are transfers. Again the students are primarily female but all start in the project in the freshman year. Class size is usually a student-teacher ratio of ten-to-one.

## PROCEDURES USED BY MURRAY STATE TRAINING ELEMENTARY SCHOOL TEACHERS IN THE AREA OF MATHEMATICS

Figure 2, below, provides a graphic description of the two approaches now in use by MSU in preparing pre-service teachers to teach elementary school mathematics. They are both similar in terms of academic credit hours. One is

| TRADITIONAL PROGRAM | | NSF FUNDED ISMEP | |
|---|---|---|---|
| | Cr. Hrs. | | Cr. Hrs. |
| MAT 115 - Fund.Concepts I | 3 | SME 100 | 6 |
| MAT 315 - Fund.Concepts II | 3 | SME 150 | 6 |
| ELE 201 - Teaching of Math. | 3 | SME 200 | 6 |
| BIO 101 - Gen. Biology | 4 | SME 250 | 6 |
| Phy.Sci.- (Several Choices) | 4 | | |
| Sci. Elec. - (Several Choices) | 4 | | |
| ELE 502 - Teaching of Sci. | 3 | | |

Figure 2.

spread over two years and the other over a period from two to four years. The content of both programs differ significantly in the are of science (both in science content and in the methodology for teaching science). As for mathematics, the programs differ in philosophy and in methodology. (A sample of SME 100 is attached as Appendix B.)

Both approaches to teacher education argue appropriate development in teacher skill and literacy. Both approaches argue appropriate development in teaching pre-service teachers how to teach. Some discussion on these questions are forthcoming in the next area for discussion - PRELIMINARY SELF ASSESSMENT.

PRELIMINARY SELF ASSESSMENT

Ideally, the philosophical foundations for the ISMEP Project are most desirable. It appears that given the limitations in attempting to coordinate the efforts of a large number of instructors that are attempting to teach two related subjects, the integration of these subjects in a "modular" format might enhance the cohesiveness necessary for teacher training. In an isolated environment there would be no problems. However, since the ISMEP approach is not in an isolated environment but rather is a part of a university system and a system of universities, close examination of the impact of ISMEP is in order.

During the second academic year of ISMEP, the enrollment of ELE 201 will be seriously impacted. In fact, the population of ELE 201 will be made up of students that have,primarily, scheduling "problems" due to transfering, returning to school after an absence, a desire for a second major outside of teacher education, etc. QUESTION: HAS THIS PROGRAM TRANSITION BEEN CLEARED BY THE UNDERGRADUATE ACADEMIC STUDIES COMMITTEE?

A related problem is the notion that the university is changing its program for teacher education in mathematics and science with no real involvement of elementary education staff, etc. QUESTION: DOESN'T IT SEEM REASONABLE THAT ELEMENTARY EDUCATION FACULTY BE INVOLVED THROUGHOUT THIS TRANSITION PERIOD? ESPECIALLY, IN THE LIGHT THAT ELEMENTARY EDUCATION FACULTY ARE GOING TO BE SERVING IN ISMEP. QUESTION: IS IT POSSIBLE THAT THE UNIVERSITY IS MAKING A STRONG AND CLEAR STATEMENT ABOUT EFFECTIVE TEACHER EDUCATION -- THE LESS INVOLVEMENT BY EDUCATIONIST, THE BETTER? Sufficed to say, curricula changes have been observed and without justification or approval by an academic committee.

PROBLEM: THE UNDERGRADUATE TEACHER EDUCATION POPULATION IS STABILIZING AND IS TENDING TO BE DECREASING IN NUMBER. Isn't it reasonable to examine the impact of ISMEP on faculty student ratio, resource-materials, budgeting, etc.? Concomitantly, students are being asked to be relatively sure of a career as a teacher by making a commitment of ten semester hours the first semester. By the end of the second semester, there will be a total commitment of sixteen semester hours to elementary education. At the same time, the university must be relatively sure that the philosophy used with our pre-service teachers is going to be somewhat useable in the school that our graduates will someday be employed. An example of a contemporary existential problem is the notion that ISMEP students spend as much, if not more, in science mods as in the mathematics mods. Our graduates will not find such distribution of emphasis in many school situations for some time to come.

Also, there is reason to believe that the mathematics component within ISMEP is not as interesting or desirable as is the science component. Perhaps this is due to the individualized technique being used or the nature of the materials. In any case, my recommendation is not to back away from ISMEP but to examine the following immediately:

1. Are pre-service elementary school teachers being adequately and appropriately trained as teachers of elementary school mathematics and science?

2. What problems exist that are going to discourage students from entering elementary school teaching?

3. Is it a viable structure to "integrate" mathematics and science here at MSU?

4. What staffing problems are going to exist when NSF funding ceases?

5. Is it beneficial to "house" teacher training programs to the students disadvantage?

6. What philosophical and economical problems exist when there are, in fact, two teacher models on campus?

## RECOMMENDATIONS

Because ISMEP is a worthwhile venture and has the potential of succeeding, the following recommendations are being made:

1. Freshman students should continue to be randomly assigned one-half to ISMEP and one-half to the traditional.

2. Elementary education faculty in mathematics and science be assigned immediately.

3. Some form of clustering of mods be determined for academic-course equivalencies.

4. The resource center be planned for either the library or Wells Hall -- the graduate program must reflect MSU's advancement as well.

5. No new program for pre-service teacher education in math and science be adopted at MSU until approval by the undergraduate studies committee.

## SECTION II

## MATHEMATICS EDUCATION: GRADUATE

Objectives

Population

Procedures

Preliminary Self Assessment

Recommendations

Objectives:

The program objectives submitted to NCATE for ELE 508: Teaching Modern Mathematics are designed to give teachers depth in modern mathematics. It provides opportunities for competency in modern mathematics as well as familiarity with current trends in teaching techniques.

The major objectives are to:

A. introduce sets and the techniques for describing them.

B. study the beginnings of numerations and the numeration systems.

C. emphasize the importance of place value in base 10 and other bases.

D. broaden the student's understanding of the four mathematical operations as they relate to modern mathematics, both in material and method.

E. develop a better understanding of points, lines, planes, closed curves, polygons, and angles.

F. explore the role of algebra and geometry in the elementary school.

G. broaden the scope of numbers and operations relating to whole numbers, rational numbers, fractions, and real numbers.

H. emphasize the use of the kinds of materials needed to teach measurement.

I. discuss applications and models such as problem solving and number sentences.

J. discuss blending of the conceptual, the computational, and the applications of modern mathematics in the curriculum.

K. familiarize student with new methods and materials.

Suggested experiences include:

A. using as resources the text, professional books, recent magazine articles, and supplementary materials for both remedial and developmental elementary programs.

B. viewing films and filmstrips relating to materials and methods.

C. participating in a group discussion on techniques for introducing basic concepts.

D. engaging in problem solving sessions.

E. examining elementary school textbooks on modern mathematics.

F. doing research into the background of our number system.

G. demonstrating various teaching techniques.

H. pursuing a depth study in some area of modern mathematics in either method, materials, or historical development.

I. evaluating the effectiveness of changes in the elementary school mathematics program.

J. evaluating new programs in modern elementary school mathematics.

K. working with elementary school children in a clinical situation.

Text and suggested supplementary books are:

The textbook is School Mathematics Study Group's Studies in Mathematics, A Brief Course in Mathematics for Elementary School Teachers Volume IX. Leland Stanford Junior University, 1963.

A. Ashlock, Robert B. and Hermon, Wayne L., Jr. Current Research in Elementary School Mathematics. Macmillan, 1970.

B. Fehr, Howard F. Contemporary Mathematics for Elementary Teachers. D. C. Heath, 1966.

C. Hirschi, L. Edwin. Building Mathematics Concepts in Grades K-8. International Textbook Company, 1970.

D. Morris and Topfer. Advancing in Mathematics. Science Research Associates, 1964.

E. Nahikian, Howard M. Topics in Modern Mathematics. Macmillan, 1966.

F. Scott, Lloyd. Trends in Elementary School Mathematics. Rand McNally, 1966.

G. Swain, Robert L. and Nichols, Eugene D. Understanding Arithmetic. Holt, Rinehart, and Winston, 1965.

The objectives listed above came in response to the "new mathematics" era. There were many terms and procedures with which practicing teachers had little background. However, the curriculum no longer reflects the "strangeness" of the "new mathematics". Therefore, the above objectives are obsolete. For students entering elementary education and needing certification, which calls for indication of mathematics competency, MAT 517 is a course designed for such students.

Consequently, ELE 508, as originally proposed, is of little use and may tend to be repetitive rather than enhancing.

In response to the need to offer a survey course in teaching elementary school mathematics at the graduate level, the following set of objectives were determined for ELE 508:

Prerequisites:

-Undergraduate methods in teaching elementary school mathematics.

-Perceptual/tactile methods for teaching arithmetic and basic math concepts.

-The process of abstraction.

Instructor identified objectives for this course:

1. Differentiate between what is being taught and what is being learned in the math class.

2. Identify and resolve some common problems in teaching math in the elementary school.

3. Demonstrate strategies for selecting and/or designing instructional materials for situation specific learning. (culture/work)

4. Demonstrate methods in teaching arithmetic.

5. Demonstrate methods for teaching mathematics.

6. Demonstrate methods of evaluation and assessment.

7. Demonstrate methods for teaching the International System of Measures.

8. Demonstrate methods for approximating individualization.

The above listing of objectives has been determined to enhance the teaching of elementary school mathematics without being a duplicate of the undergraduate methods class. The past year's attempt to meet such objectives has fostered many observations. Before sharing those observations, a look at the population and the procedures used is necessary.

Population:

The population is varied indeed. There are elementary school teachers from various instructional levels, from various school situations and with varying reasons as to why they are taking the course. There are secondary teachers seeking endorsement as elementary school teachers. Some secondary teachers are trying to find ways to help poorer students in arithmetic. Some are seeking an easy "A" at the graduate level for various reasons. There are pre-service undergraduates that are seeking "in depth" training in the teaching of mathematics. There are special education majors and reading specialists that need the class as a requirement for graduation. There are those education majors that are taking the class because it is the only elective available for their present scheduling needs. There are those who really don't need the course but must take it. Those students getting their Masters take it. Those students getting their Thirty Hours above

take it. Those students getting their specialist degrees take it. As you can see, the course often tends to be a catch all that must meet the needs of many kinds of students -- and very often falls far short of the mark because of such constraints.

Procedures in Meeting Course Objectives:

The assumption for ELE 508 is that it is to be an enhancement of the teaching of mathematics in the elementary school. This would imply that there are prerequisite experiences that have already been met. Hopefully, an undergraduate methods class would have been taken as well as an undergraduate ( or its equivalent) in the fundamentals of arithmetic and geometry.

As was expected, students would be of varying backgrounds as previously described in the Population section of this paper. Therefore, the ELE 508 experience had to be both an "enhancement" experience as well as a "fundamentals" experience in arithmetic and geometry along with the related methodology. (Believe me! This is a no-win situation.) Hence, ELE 508 in actual design is now fairly non-traditional in its structure as a graduate and as an undergraduate course.

The objectives for ELE 508 are being presented as a philosophical base to allow instructors the flexibility necessary to meet the needs (as best as possible) of students depending on the following variables:

On Campus - Fall and Spring
Off Campus - Fall and Spring
On Campus - Summer.

The variable of when and where the course is offered tends to reflect the nature of the student taking the class. The ramification and recommendation for this concern will be reflected in the discussion that follows in the section entitled Recommendations.

The paradigm for implementing ELE 508 is a rather simple one. The main goal is to enhance the methodology and the mathematics understanding of students as well as to enhance (affect) how teachers teach mathematics to elementary school children. The main feature in delivering this approach is via high student involvement. That is to say, the approach is to get students to actually "teach" as much as possible. Theorizing and philosophying is incidental to rationaliz ing the approach that is being or that has been used with children.

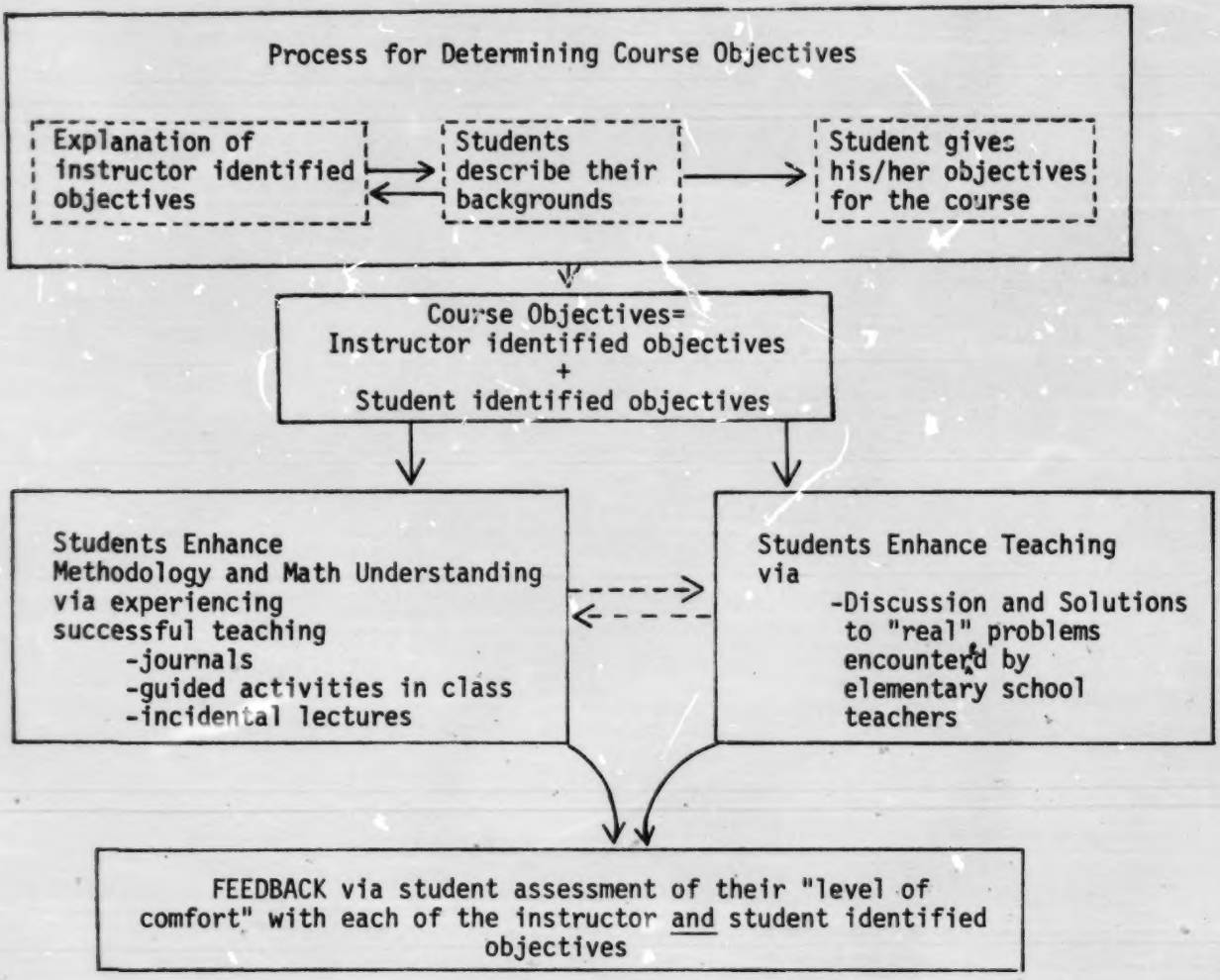
Process for Determining Course Objectives
Explanation of instructor identified objectives
Students describe their backgrounds
Student gives his/her objectives for the course
Course Objectives=
Instructor identified objectives
+
Student identified objectives
Students Enhance Methodology and Math Understanding via experiencing successful teaching
-journals
-guided activities in class
-incidental lectures
Students Enhance Teaching via
-Discussion and Solutions to "real" problems encountered by elementary school teachers
FEEDBACK via student assessment of their "level of comfort" with each of the instructor and student identified objectives

Figure 3.

Preliminary Self-Assessment:

The practicality of the course structure presented in Figure 3 above is a good "second best" alternative in meeting the goals of the population that tends to take the course ELE 508. The emphasis here is on "second best". It is a sincere hope that Murray State University is seeking the best. Therefore, this section will attempt to outline, in detail, the nature of problems that plague ELE 508 and its place in the undergraduate, fifth year, masters, and thirty hours above programs. Some suggested avenues for improvement will be outlined in the last section (Recommendations).

The course is used by students to meet one of several personal objectives:

-as an elective for the Bachelors degree
-as an elective for the Masters degree-elementary
-as an elective for the Masters degree-special education
-as an elective for the Masters degree-reading
-as an elective for the Fifth Year Program
-as an elective for the Thirty Hours Above Masters Program.

The MSU catalog gives the following description for ELE 508:

"Teaching Modern Mathematics - Designed to give elementary teachers depth in modern mathematics. Students become familiar with current trends and programs and develop competency in guiding children in developing mathematical concepts."

Here, the words "depth", "trends", and "competency" are very meaningful but tend to imply a "survey" set of experiences. Yes! A survey set of experiences without regard to the fact that most students are practicing teachers and have already had a "survey" set of experiences. However, before proceeding, let's clarify the notion, immediately, as to whether ELE 508 has a place at MSU. It does! If there is a deficit in undergraduate experiences in teaching elementary school mathematics or a severe time lapse where the student has been removed from mathematics teaching, then ELE 508 is the course in order. ELE 508 as a "survey" course will be most logical for a non-practicing teacher of elementary school mathematics. Concomitantly, though, the practicing teacher of elementary school mathematics needs more than ELE 508 has to offer. It also stands to reason that students in the Thirty Hour Above and the Specialist Programs should be given other alternatives for becoming more proficient in one of the areas that each must teach and is classified as "basic". Our graduates need more experiences that lead to proficiency (more than just "minimum" competency).

It is a very tempting idea to change the modus operandi of ELE 508 when teaching off campus. The primary reason for this is the preparation time due to limited library facilities away from campus. Course integrity is a must and can best be adhered to if the support system is available. A recommendation on this matter is forthcoming.

Grading in ELE 508 is a problem because if there is a list of activities to be done (a written exam excluded) students will work faithfully and diligently at the level of performance determined by the instructor. Needless to say, there is a real "fear of failure" among graduate students. Marry to this fact the notion that many elementary education students are terrified at the mention of the word "mathematics" and you will have the complete picture. The goal of the graduate program in Instruction and Learning should be to produce students that are minimally literate in scholarly matters relating to teaching and learning and

maximally predisposed to the enhancement of teaching and learning. The experience, so far, indicates that by practicing this philosophy, by making the same kind of emphasis in affecting student performance, there tends to be a direct parallel in outcomes. A recommendation on grading in ELE 508 is forthcoming.

Summarily, students that complete ELE 508 indicate positive feelings about their experiences in the course. All course objectives are never met. Students feel extremely rushed and wish there was greater emphasis on some component of great importance to them. They wish there were more modeling experiences by the instructor -- particularly in "getting Johnny to . . .". (My personal assessment is that many of the skills that I have spent years developing concerning the teaching-learning interaction during mathematical situations usually get only a brief mention. Consequently, I never really get to the point of helping teachers in demonstrating successful behavior. The list goes on. . .). Generally, ELE 508 is a component of one of the most important experiences for which teachers are being held accountable and there is no (I repeat!) no opportunity for proficiency experiences here at Murray State University.

Recommendations:

The goal of graduate and upper level offerings in mathematics education should be directed towards proficiency in teaching mathematics. The mathematics department can provide experiences to make the student literate, but Instruction and Learning must provide the leadership in helping students in negotiating matters related to the teaching-learning process with school children. The basic structure for mathematics education here at Murray State should be as in Figure 4.

MATHEMATICS EDUCATION (K-8) AT MURRAY STATE UNIVERSITY

| Experience / Level | Literacy in Mathematics | Methodology in Teaching Mathematics |
|---|---|---|
| Bachelors | From MSU Math Dept. MAT-Foundations (3-6 hours) | From Department of Instruction and Learning 3-6 hours |
| Masters Fifth Year Endorsement | From MSU Math Dept. MAT-Foundation (if necessary) | From Department of Instruction and Learning 3 hours |
| Thirty Hours Above and Specialist | | From Department of Instruction and Learning 3-9 hours |

Figure 4.

Figure 4. clearly outlines the necessity for literacy and methodology. Both the mathematics department and the department of instruction and learning can share in the development of minimally competent and, to some degree, proficient teachers of elementary school mathematics. At the present, MAT 115, MAT 315, and MAT 517 make up the contribution offered by the mathematics department. ELE 201 and ELE 508 make up the contribution offered by the Department of Instruction and Learning. However, the recommendation illustrated in Figure 4. specifies a greater number of hours in methods at both the undergraduate and graduate levels.

Recommendation One:

Dependent upon the background of individual students in mathematics foundations, ELE 508 can be taken in lieu of either MAT 115 or MAT 315. (This should affect a small number of students.) The rationale for this recommendation is the fact that some undergraduates already possess the competency for MAT 115 and/or MAT 315 and should be encouraged to take the CLEP examination. The offsetting problem here are those that come from the present structure of the ISMEP approach. However, as a nobler goal, the integrity of teacher training is at stake and a more facilitative approach is necessary in the wake of the decreasing teacher education population.

Recommendation Two:

ELE 508 be maintained as an upper level survey course in methodology and students with no elementary teaching experience and no undergraduate methods course (i.e. ELE 201 or SME 100-250) be the central focus as a population.

The rationale for this recommendation is that ELE 508 will be a necessary attempt at insuring minimum competency for people entering the elementary school as a teacher of mathematics without having to duplicate the undergraduate experience or suffer the consequences of an undergraduate course number.

Recommendation Three:

ELE 508 not be offered each and every semester. In order to control the population flow and to encourage population flow into other mathematics teaching experiences, a schedule of offering ELE 503 once during the academic year and once during the summer may be more reasonable in meeting both university and student needs.

Recommendation Four:

Class enroll ment for ELE 508, necessarily, be limited to fifteen students. In order for this experience to be a "modeling" experience for teaching mathematics in the elementary school, the smaller number is necessary. To increase the number increases the likelihood of little or no modification of actual teaching behavior. The best that can result will be "ideas".

As to whether the student "knows" what to do and can demonstrate his/her competency, there will be serious question.

Recommendation Five:

Three classes be designed to increase the proficiency level of elementary school teachers in the teaching of mathematics.

These courses should be designed as follows:

ELE 6__: Teaching Mathematics in the Primary Grades K-2
Emphasizing:
- -How children learn to count
- -Activities and procedures for helping children in counting
- -Diagnosing and remediating counting errors
- -Helping children to describe experiences using numbers
- -Helping children to describe spatial experiences using geometric relations
- -Helping children to describe experiences using graphic and symbolic representations
- -Helping children to use graphic and symbolic representations in solving problems
- -Successful management models

ELE 6__: Teaching Mathematics in the Intermediate Grades 3-5
Emphasizing:
- -Diagnosing and remediating arithmetical errors
- -Using measurement as a tool
- -Developing the four basic algorithms
- -Using spatial relations
- -Developmental and reinforcement strategies for mastery learning
- -Problem solving using patterns and arithmetic
- -Successful management models

SEC/ELE 5__: Teaching Mathematics in the Middle and Junior High School Grades 5-8
Emphasizing:
- -Diagnosing and remediating arithmetical errors
- -Developing the four basic algorithms over the rational and real numbers
- -Develop measurement concepts
- -Career and life long use models
- -Developmental and reinforcement strategies for mastery learning
- -Problem solving
- -Successful management alternatives

Basically, these three courses would pretty well cover the needs of the students that tend to take ELE 508 presently. Also, students from Child Studies, Special Education, and Secondary Education would have a clearer rationale for taking specific courses. The SEC/ELE 5__ is planned to incorporate the anticipated Middle School Certification package presently on the drawing boards.

Recommendation Six:

The above recommended courses each be offered at least once a year but not more than twice.

Recommendation Seven:

Development time must be made available for writing the materials for ELE 508. The 1978-79 Teacher Corps Project will be helpful here.

Recommendation Eight:

Development time must be made available for designing the three new courses recommended in this paper.

Recommendation Nine:

The grading system for ELE 508 be equivalent to credit-no credit.

Because of the affective and cognitive problems already alluded to in this paper, this will allow for greater productivity and involvement on the part of students and instructor. Also, because students are most likely (because of evaluation and assessment weaknesses) to get "A's" and "B's", there will be less grade inflation. In all likelihood there will probably be a better Murray State product -- at least in the area of teaching elementary school mathematics.

## SECTION III

## MATHEMATICS EDUCATION: PROVIDING REGIONAL LEADERSHIP

Objectives

Population

Procedures

Preliminary Self Assessment

Recommendation

Objectives:

Murray State needs to establish a mathematics laboratory for providing services to area teachers. The ISMEP program is a fine first effort. However, there needs to be a greater thrust that would enhance the Kenlake Council of Teachers of Mathematics as well as negotiating specific services with school systems.

Population:

Because of the present change in teacher education, the future will demand that Murray State provide services to teachers that will not be seeking professional renewal through traditional university courses. The need is there. This population is growing.

Procedures:

To be determined.

Preliminary Self Assessment:

Teachers are not going to attend such courses without a personal reason to their advantage. Very little has been done to assess how teachers can be served in this region.

Recommendations:

The Murray State Center for Innovation and Development and the West Kentucky Education Cooperative should work together with those involved in mathematics education in seeking both models and funds for establishing teacher renewal in mathematics teaching. These offices should inform the faculty in mathematics education of grant opportunities, etc. that will aid Murray State in serving its designated geographic region.

## APPENDIX A

CHECKLIST of Assignments for the Course: Teaching of Mathematics (ELE 201)

Assignment (Task)

_____ 1.1 Complete the laboratory activities listed.

- _____ Classifying, Ordering, Counting
- _____ Symbols for Number - Numeration
- _____ Addition
- _____ Subtraction
- _____ Multiplication
- _____ Division
- _____ Informal Geometry
- _____ Number Theory
- _____ Making Comparisons
- _____ Pictorial Representation
- _____ Chance

_____ 1.2 Use appropriate developmental aid (not just reinforcing) in helping learners attain an identified objective.

_____ 2.1 Answer all questions in the assignment titled: Teaching Strategies.

_____ 2.2 During your experience with children, use a teaching strategy consistent with your desired outcomes.

_____ 3.1 Answer the question in the assignment titled: Reinforcing Learning for Mastery and Maintenance.

_____ 3.2 When reinforcing a mathematical idea with children, you will demonstrate that you can maintain participation of learners by your selection and by not overusing any reinforcing strategy.

_____ 4.1 Answer the questions in the assignment titled: Grouping, Assigning Tasks, and the Use of Motivational Devices.

_____ 4.2 You will use the knowledge of each of your learners to group, assign tasks, and in the implementation of your lessons.

_____ 5.1 Answer all questions in the assignment titled: Goals, Scope and Sequence: K-8.

_____ 5.2 From the objectives K-8, select an attainable objective for your learners.

_____ 6.1 Hand in a documented report of your teaching.

_____ 6.2 Teach according to: Guidelines for Teaching During the Course: Teaching of Mathematics (ELE 201).

Consider the following when using psycho-motor (concrete or manipulative) materials:

a. The representation should force pupils to attach meaning to the symbols;
b. The representation should be mathematically honest and not too phoney or contrived;
c. The representation should, if possible, be adoptable to more advanced related work;
d. The representation should, if possible, be adoptable to more advanced potential physical hazards;
e. If the topic will eventually lead to an algorithm, the interpretation should suggest the algorithm or, second best, give answers that might suggest an algorithm. (Consult THE ARITHMETIC TEACHER, October 1976 for more detail.)

Consider when using perceptual (pictorial, semiconcrete, diagrammatic) materials:

_____ Neatness and clarity
_____ Size and type of lettering
_____ Relevance to the learner
_____ Does the learner have to make several mental manuevers to "see" the idea?
_____ Plus all of the ideas considered to psycho-motor materials.

Consider when materials are primarily verbal:

_____ Clarity
_____ Variability
_____ Enthusiasm
_____ Use of student ideas
_____ Criticism
_____ Types of questions
_____ Refer to psycho-motor or perceptual experience when necessary.

You will be observed and given feedback during your work with children.

AREA ONE - Teaching Through Developmental and Mastery Learning Strategies



Rationale

In teaching elementary school mathematics, you use manipulative (psycho-motor), pictorial (perceptual), or symbolic (verbal) materials to develop understanding of a concept. You use a variety of drill and practice techniques to help the learner gain mastery of a concept or skill. The task for you is to help the learner's attention and interest and expedite as efficiently as possible the attainment of specified goals.

Area One is designed to help you match teaching aids and procedures. As an elementary school teacher, you will be certified to teach anywhere from the first grade to the eighth grade. The topics or strands taught in these grades are:

Non-Metric Geometry
Number and Numeration Development
Operations and Their Properties
Mathematical Sentences
Measurement
Charts, Graphs, and Tables
Statistics and Probability

Please don't let these mathematical labels frighten you. These topics or strands are dealt with very elementary and most teachers get to feel quite comfortable with them.

Procedure:

For most of you it is going to take the entire semester to complete four objectives or competencies for AREA ONE. Therefore you are advised to refer constantly to your course schedule to be sure you are scheduling your time wisely.

Answer all questions and complete all tasks for each objective or competency.

TO DEMONSTRATE OBJECTIVE 1

(Demonstrate appropriately psycho-motor and perceptual aids in conceptualizing mathematics concepts and skills.)

Complete the following tasks:

_____ Classifying, Ordering, Counting
_____ Symbols for Number-Numeration
_____ Addition
_____ Subtraction
_____ Multiplication
_____ Division
_____ Informal Geometry
_____ Number Theory
_____ Making Comparisons
_____ Pictorial Representation
_____ Chance

1.2 Use appropriate developmental aids (not just reinforcing) in helping learners attain an identified objective.

TO DEMONSTRATE OBJECTIVE 2

(Demonstrate the ability to sequence learning from "real experience" to the more abstract form of experience.)

Once you have decided what you are going to teach, it will then be important that you decide how you are going to teach it. The particular objective that you will meet here requires you to build on the learner's experience in helping him/her in abstracting a new idea. During this assignment, you will examine some ways of building on experience. Your assignment for objective four will alert you to the source of experience upon which you will build.

In helping you to develop strategies for developing concepts you will examine ten specific methods. These methods are:

a. Teach with high learner involvement---every child participates in the learning activity at the same time, (oral, physical, or written displays).

b. Teach with analogy---use a story-type situation to demonstrate a concept.

c. Teach, using a form of analysis, is the method of breaking a concept down into a step-by-step explanation.

d. Teach using rules or generalizations---state a rule or generalization and then proceed to illustrate example--constantly referring back to the rule or generalization.

e. Teach using definition---a process similar to using rules or generalizations with the distinguishing feature being in the use of definition. The rule or definition along with true and false examples are displayed. The learner must test each example to determine illegal cases.

f. Teach using guided laboratory activities---hear a problem situation is created for the learner who then proceeds step by step (following instructions) in gathering data to resolve a question already asked or suggest possible hypothetical conclusions.

g. Teach using symbolic translation---in this instance the learner uses new symbols for old concepts to generate a special concept. (For instance, using place value and common fractions to extend the decimal numeration system.)

h. Teach using models---psycho-motor and perceptual aids are used to aid in abstracting a concept or giving meaning to symbols.

i. Teach using examples---this method differs from the methods of analysis, rules, and definition in that the rule, definition, or generalization is not given to the learner. The learner will "see" it after many examples before a formal statement of the rule or generalization.

j. Teach using pure discovery---(the inquiry or Socratic method), here the teacher asks a question about some problem situation. The teacher continues to raise questions until the problem situation has been resolved to the satisfaction of all parties.

Complete the following tasks:

2.1 Answer all questions in the assignment titled Teaching Strategies. (This assignment will be given to you in class.) Resources for answering the questions are supplied in the unit. Attending class and/or reading related materials should be sufficient. The purpose of the assignment will help you to match your strategy with your desired outcomes.

2.2 During your experience with children, use a teaching strategy consistent with your desired outcomes.

TO DEMONSTRATE OBJECTIVE 3

(Demonstrates a variety of ways of reinforcing learning for mastery)

One of the biggest concerns and hence a source of management problems is the use of repetition in aiding learners to master and remember specific concepts and skills. In mathematics there are almost a myriad of skills and subskills. Unlike other subject areas, mathematics skills are not practiced and reinforced in our normal communication mediums. You can imagine children (and adults as well) talking about place value, the area of a rectange, or parallelograms. It is true that these ideas exist for the individual in their private world but they are not usually referred to formally. Not too many games, television shows, etc., really refer to many of the ideas learned in mathematics. For most children, if it were not for schooling, the amount of mathematics learned would be minimal and consequently many doors would be almost automatically closed to these learners.

The teacher and the school are important when it comes to learning most mathematics--that is--as we traditionally view elementary school mathematics.

Repetition can be boring and, worst yet, it may create mental blocks or negative attitudes which will tend to stifle future learning of mathematics. How many of you can claim an exciting and enriching experience in mathematics? Smile! You are one of the lucky ones. From grades one through eight, mathematics tends to be quite repetitious. It appears to be going in circles each year with greater difficulty added each time, however, through it all, learners have to keep reviewing getting higher scores on accuracy and "seeing" the new steps you have added.

Most of you will spend anywhere from one week to a month on a given unit--i.e. subtraction of whole numbers. You will find that many learners tend to forget what was learned from day to day or week to week. (You can bet on month to month and over the summer vacation.) So, is it going to be flash cards everyday? Worksheet after worksheet every day and night? Games and nauseum? Keep teaching the same old unit or lesson until they get it? Continually drilling ideas that are without meaning to the learner? But, HARK! There are

sane and rather pleasant ways of reinforcing learning for mastery and maintenance. (There had better be since approximately 50% of your efforts as an elementary school teacher of mathematics will be spent doing just that.)

During this assignment, you will examine five of the ways of making drill and practice palatable. These are:

a. paper and pencil
b. mental and flash card
c. gaming
d. embedding in new concepts
e. enrichment

Complete the following tasks:

3.1 Answer the questions in the assignment titled: Reinforcing Learning for Mastery and Maintenance. By the end of the assignment you will have ideas for varying drill and practice using the five ways suggested.

3.2 When reinforcing a mathematics idea with children, you will demonstrate that you can maintain participation of learners (by your selection and by not overusing any reinforcing strategy.)

TO DEMONSTRATE OBJECTIVE 4

(Demonstrate knowledge of affective concerns in learning mathematics and how to deal with them.)

Several courses can be designed around this objective. This objective will be life-long for most of us as we seek more efficient ways to produce better mathematics learning. So please do not feel slighted if you do not reach the level of adequacy for this objective.

The effective concerns that will be dealt with here are those that will assist the learner in directing his/her attentions toward a specific objective. Some hindrances may come from very private, social, physical, and emotional needs. Other hindrances may stem from intra class room arrangements. While still others may stem from the learner's "learning set"--the ways he gains and processes information. This latter case will be attended to mostly in this assignment.

How one gains and processes information may imply the need for individualization. It does; however, most of you will be in situations where individualization will never be achieved. The best you will do will be little more than approach individualization. Consequently this assignment will examine some of the ways you group, assign learner tasks, and suggest some ways to use social experience of learners as motivational devices.

Complete the following tasks:

4.1 Answer the questions in the assignment titled: Grouping, Assigning Task, and the Use of Motivational Devices.

4.2 You will use the knowledge of each of your learners to group, assign tasks, and in the implementation of your lessons.

TO DEMONSTRATE OBJECTIVE 5

(Demonstrate knowledge of the scope and sequence of concepts and skills taught from kindergarten through eighth grade.)

"They don't really teach algebra in the elementary school, do they?" "What's this I hear about geometry?" "I was really bad in geomerty. In fact, I hated it." "And this stuff about probability and statistics. I never even heard of it until I got to college. Now they are teaching it to elementary school children. NO WONDER THE NEW MATH FAILED!"

"You have to be kidding! That's what you call algebra! And that geometry is so easy that any child ought to be able to do it. And who would have ever guessed that school-age children experience more probability and statistics in their everyday life than any other area of mathematics. TEACHING MATHEMATICS IS GOING TO BE EASY! I KNOW AND UNDERSTAND IT ALL OR AT LEAST I KNOW I CAN!"

Each and every one of you will be able to exclaim the above statement as you complete this assignment. Those of you that have already peeked in textbooks can already exclaim it. This assignment will be one of the shortest for this course. But PLEASE...don't assume that you are an authority on what is being taught in elementary curriculum. There are many cognitive behaviors and curricula topics in some school districts around this country that address a very unique set of mathematics behavior and concepts not dealt with here. However, you can feel assured that what you examine is indicative of that which is done in most school districts in this country.

Hopefully, in meeting the needs of your learners you will be able to prescribe a topic for study at their level of need and interest. Yes, some of you will gain enough to aid you in designing the course of study for your learners--even without reinventing the wheel.

Complete the following tasks:

5.1 Answer all questions in the assignment titled: Goals, Scope and Sequence: K-8.

5.2 From the scope of objectives K-8, select an attainable objective for your learners. Demonstrate the nearest prerequisites for the objective and the objective for which your attainable objective is a prerequisite.

TO DEMONSTRATE OBJECTIVE 6

(Demonstrate the ability to help learners attain an identified objective.)

CAN YOU TEACH? Did you reach your goal? Did you reach your goal partly? OK. How do you know? Your learners indicated so.

Was there a better way to do it?

Did you overlook something?

Did you really do what you said you were going to do?

Do you feel good about what you did?

Well, there are several avenues one could follow to help you answer those questions. Basically, these would be either you looking at yourself while you teach or somebody else looking at you while you teach. Well, you are truly fortunate. You are going to have it both ways!

This objective or competency is the synthesis or the putting-it-all-together objective. The emphasis will be on feedback--introspectively and extrospectively. It is designed to assist you in becoming that successful teacher you want to be. Remember this! We can only assist you in becoming that successful teacher. We can be the most advanced profession and doctors, lawyers, etc. had better take heed.

Complete the following tasks:

6.1 Use tests, worksheets, lesson plans, evaluation, and self-reports in the documentation of your teaching. Consult the handout titled: Guidelines for Teaching During the Course: Teaching Elementary School Mathematics.

6.2 Teach in an elementary school classroom following the handout titled: Guidelines for Teaching During the Course: Teaching Elementary School Mathematics.

I S M E P

Fall 1977

Grade Options: 42 MODs/A; 35 MODs/B; 30 MODs/C

| Required MODs | Instructor(s) |
|---|---|
| 100 - Introduction to SAPA, SCIS, and ESS | Dr. Crafton |
| 101 - Use of Calculator | Dr. Parker<br>Dr. Crafton |
| 102 - Observing (Group Activity) (SAPA) | Dr. Johnson<br>Dr. Crafton |
| 103 - Numeration<br>Activities 1, 2, 4, 5 | Dr. Parker<br>Dr. Crafton |
| 104 - Material Objects (SCIS)<br>Observing, classifying | Dr. Johnson<br>Dr. Crafton |
| 105 - Numeration<br>Activities 7, 8, 11, 12, 13 | Dr. Parker<br>Dr. Crafton |
| 106 - Classifying (SAPA)<br>Punch Cards | Dr. Johnson<br>Dr. Crafton |
| 107 - Teaching Children: Numeration<br>Activity 16 | Dr. Crafton<br>Dr. Parker |
| 108 - Formulating Hypotheses (SAPA)<br>Hypothesizing concerning the behavior of a mystery light box | Dr. Johnson<br>Dr. Crafton |
| 109 - Graphing<br>Activities 1, 3, 4, 7 | Dr. Parker<br>Dr. Crafton |
| 110 - Controlling Variables (SAPA)<br>Climbing Liquids | Dr. Johnson<br>Dr. Crafton |
| 111 - Graphing<br>Activities 8, 9, 10, 11 | Dr. Parker<br>Dr. Crafton |
| 112 - Experimenting (SAPA)<br>Learning Codes | Dr. Johnson<br>Dr. Crafton |
| 113 - Teaching Children: Graphing Concepts | Dr. Crafton<br>Dr. Parker |
| 114 - Seminar on Inquiry and Children | Dr. Crafton |
| 115 - Rational Numbers<br>Activities 7, 8, 9, 10, 11 | Dr. Parker<br>Dr. Crafton |

| Required MODs (Continued) | Instructor(s) |
|---|---|
| 116 - Small Things<br>Observing | Dr. Crafton |
| 117 - Rational Numbers<br>Activities 12, 13, 14, 15, 16 | Dr. Parker<br>Dr. Crafton |
| 118 - Characteristics of Living Things<br>Observing, experimenting | Dr. Johnson |
| 119 - Rational Numbers<br>Activities 25, 27, 29, 30, 31 | Dr. Parker<br>Dr. Crafton |
| 120 - Evaluating Video-Taped Science Lessons | Dr. Crafton<br>Dr. Johnson |
| 121 - Teaching Children: Rational Numbering | Dr. Crafton<br>Dr. Parker |
| 122 - The Chemistry of Life - Self Instructional Module | Dr. Johnson |
| 123 - Cell Structure and Function - Self Instructional Module | Dr. Johnson |
| 124 - Life Cycles (SCIS)<br>Observing, communicating, defining operationally | Dr. Johnson |
| 125 - Communities (SCIS)<br>Controlling variables, experimenting | Dr. Johnson |
| 126 - Creating a MOD<br>Outlining: objectives and final assessment | Dr. Crafton<br>Dr. Johnson |
| 127 - Peer Teaching (utilizing MOD 125) | Dr. Crafton<br>Dr. Johnson |
| 128 - Teaching Children (utilizing MOD 125) | Dr. Crafton<br>Dr. Johnson |

The following are ELECTIVE MODs; no more than 2/3 of these MODs may come from either Science or Mathematics.

| | |
|---|---|
| 129 - Nutrition<br>Interpreting Data, formulating hypothesis | Dr. Johnson |
| 130 - Stimuli and Responses<br>Defining operationally | Dr. Johnson |
| 131 - Organisms<br>Observing, classifying, inferring | Dr. Johnson |
| 132 - Plant Groups<br>Observing, classifying | Dr. Johnson |

| Elective MODs (Continued) | Instructor(s) |
|---|---|
| 133 - Animal Groups<br>Observing, classifying | Dr. Johnson |
| 134 - Growing Things<br>Measuring, interpreting data | Dr. Crafton |
| 135 - Cell Division and Growth<br>Observing, predicting, interpreting data | Dr. Johnson |
| 136 - Mitosis<br>Inferring | Dr. Johnson |
| *137 - Adding and Subtracting<br>Activities 1, 2, 3, 4, 5, 6, 7 | Dr. Parker<br>Dr. Crafton |
| *138 - Adding and Subtracting<br>Activities 8, 9, 10, 11, 12, 13, 14 | Dr. Parker<br>Dr. Crafton |
| *139 - Adding and Subtracting<br>Activities 16, 17, 20, 22, 26 | Dr. Parker<br>Dr. Crafton |
| *140 - Teaching Children: Adding and Subtracting | Dr. Parker<br>Dr. Crafton |
| *141 - Numeration<br>Activities 3, 6, 9, 10, 14, 15 | Dr. Parker<br>Dr. Crafton |
| *142 - Graphing<br>Activities 2, 5, 6, 13, 14 | Dr. Parker<br>Dr. Crafton |
| *143 - Rational Numbers<br>Activities 17, 19, 22, 23, 26, 28 | Dr. Parker<br>Dr. Crafton |
| *144 - Rational Numbers<br>Activities 17, 19, 22, 23, 26, 28 | Dr. Parker<br>Dr. Crafton |
| *145 - Rational Numbers<br>Activities 33, 34, 35, 36, 37 | Dr. Parker<br>Dr. Crafton |
| *146 - Exploring Children's Thought:<br>Piaget-type Interview | Dr. Crafton<br>Dr. Parker |
| *147 - Building teaching or games for Numeration, Graphing, Adding and Subtracting and/or Rational Numbers | Dr. Parker<br>Dr. Crafton |
| *148 - Numeration Activity 15; Graphing Activities 13, 14; Rational Numbers Activities 17, 19 | Dr. Parker<br>Dr. Crafton |

*Mathematics MODs